



WORKING PAPER

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Agenda Item 2: Aerodrome operations – improving airport performance

2.2: Performance-based navigation (PBN) – a practical way to improve airport performance with safety and efficiency

FOSA PROCEDURES IN JAPAN

(Presented by Japan)

SUMMARY

In line with its national ATM future concept CARATS, Japan has started the process of introducing an RNP authorization required approach (RNP AR), for which a flight operational safety assessment (FOSA) is required. This paper presents the FOSA procedures in Japan as an example of one of the states' internal rule.

Action: The conference is invited to share as appropriate current status on RNP AR deployment as well as relevant FOSA documentation and implementation.

1. INTRODUCTION

1.1 The *Performance-based Navigation (PBN) Manual* (Doc 9613) describes the need to conduct a flight operational safety assessment (FOSA) when introducing required navigation performance (RNP) authorization required approaches (RNP AR). However, very little guidance for this methodology exists in the public domain.

1.2 Instrument Flight Procedures Panel (IFPP), Eighth meeting of the working group of the whole held in March/April 2011 completed the task to draft a FOSA guidance material. The draft is based on the EUROCONTROL document, and it is now up to ICAO to decide where it should reside.

2. DISCUSSION

2.1 The Japanese ATM future concept collaborative actions for renovation of air traffic systems (CARATS) defines the introduction of RNP AR as one of the primary short-term implementation items. In January 2012, the Civil Aviation Bureau, Japan (JCAB) introduced RNP AR at Odate-Noshiro airport which is located in mountainous area. An airline has reported that, by the introduction of RNP AP at Odate-Noshiro, the approach flight path has shortened by approximately 50km per flight in comparison with the existing ILS circling approach procedure. In addition, the minimum height was improved from 944 ft to 351 ft and the landing visibility minimum was lowered from 2 400 m to 1 400 m. JCAB has since deployed RNP AR at four other airports in Japan (Kochi, Kita-Kyushu, Hakodate and Haneda) and plans to continue such deployment at airports where operational benefits are expected by RNP AR.

2.2 In preparation for the introduction of RNP AR at Odate-Noshiro, it was naturally essential for JCAB to establish FOSA procedures even before the ICAO guidance becomes available. JCAB therefore contracted with Det Norske Veritas (DNV) in 2009 to study introduction of FOSA at an airport in Japan. The work performed by DNV included a FOSA Seminar (November 2009), Safety Workshop #1 (November 2009), Safety Workshop #2 (February 2010), meeting with European organizations/airlines participated in FOSA for Tromso airport and/or Bastia airport (February 2010), and relevant documentation.

2.3 Following the DNV study, JCAB has developed a national document “Procedures of Flight Operational Safety Assessment (FOSA) for RNP AR Approach” in October 2011 as shown in the Appendix. The procedures are based on EUROCONTROL’s “Guidance Material on Flight Operational Safety Assessment (FOSA) for RNP AR APCH”, ICAO’s Safety Management Manual (Doc 9859), and learning experience with DNV stated in subparagraph 2.2 above.

2.4 JCAB is aware that EUROCONTROL describes the depth of FOSA and the possibility of a less detailed FOSA or no FOSA as experience is built up. JCAB, however, is conservative on this point and has made it a rule to conduct a FOSA for every RNP AR. JCAB is looking forward to sharing information with other member states regarding RNP AR deployment as well as relevant FOSA documentation and implementation.

3. CONCLUSION

3.1 The Conference is invited to share as appropriate current status on RNP AR deployment as well as relevant FOSA documentation and implementation.

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APPENDIX

Procedures of Flight Operational Safety Assessment (FOSA) for
RNP AR Approach

Ver. 1.0

Civil Aviation Bureau, Japan (JCAB)

Chapter 1: GENERAL

1.1 Objectives

Based on the standards and recommended practices in ICAO Annex 11 and the guidance in Performance-based Navigation (PBN) Manual (Doc 9613), this document establishes a procedure to conduct a Flight Operational Safety Assessment (FOSA) for the introduction, amendment, and post-implementation monitoring of RNP Authorization Required Approach (RNP AR APCH).

1.2 Application

In accordance with the procedures herein, FOSA shall be conducted for each RNP AR APCH which is established or amended. If the system definition clarified in 2.1.4 is changed, FOSA shall be conducted except when the change has no effect on the documented safety assessment.

1.3 Definitions

RNP Authorization Required Approach (RNP AR APCH): An approach procedure which could necessitate navigation accuracy, navigation performance, and navigation functional requirement (including on-board performance monitoring and alerting) that fulfilled the minimum lateral navigation error of ± 0.1 NM for 95 per cent of the flight time, and which would require stakeholders to conduct a FOSA.

Safety: The state in which the possibility of harm to persons or of property damage is reduced to, and maintained at or below, an acceptable level through a continuing process of hazard identification and safety risk management.

Hazard: Any contributor (event or action) which could induce an accident or an incident.

Safety Risk: The harm that arises as a consequence of hazard, which is expressed in terms of predicted probability and the severity, taking as reference the worst foreseeable situation.

Safety Risk Management: A series of activities that encompass the identification of hazards, the analysis of the safety risks of the consequences of hazards, the assessment of the safety risk tolerability, and the mitigation of safety risks to a level as low as reasonably practicable.

Chapter 2: FRAMEWORK OF FOSA

2.1 FOSA Session

2.1.1 A FOSA session is held to assess the safety of operation of the proposed RNP AR APCH.

2.1.2 A FOSA session conducts a safety risk management.

2.1.3 The attendees of a FOSA session are the eligible personnel for a safety risk management of the RNP AR APCH, who are in charge of respective fields of duty in the related organizations (JCAB and aircraft operators) that join the FOSA task force described in 2.2.3.

2.1.4 A FOSA session is held after clarifying the following system definition with due consideration for the airport and the flight path of the proposed RNP AR APCH procedure, the aircraft operator and their aircraft wishing to obtain approval to fly the RNP AR APCH, the scheduled starting date of operation, and so forth.

- (a) The proposed procedure design and details of the proposed navigation database;
- (b) Aircraft information;
- (c) Proposed Minimum Equipment List;
- (d) Operating procedures required for flight crew/ dispatcher/ aircraft operator;

A-3

- (e) Knowledge and training required for flight crew/ dispatcher;
- (f) Airport and airspace environment;
- (g) Navigation infrastructure;
- (h) ATC facilities, procedures and training with respect to RNP AR APCH;
- (i) Monitoring program (post-implementation assessment).

2.1.5 A facilitator who maintains neutrality presides at the safety risk management in the FOSA session.

2.1.6 The attendees of a FOSA session make maximum efforts to collect safety related information through the use of previous safety assessments and so forth.

2.1.7 The safety risk management in the FOSA session is repeated through any form of qualitative and/or quantitative assessments until all hazards are mitigated to tolerable levels.

2.1.8 The outcome of the safety risk management in the FOSA session shall be documented.

2.2 FOSA Task Force

2.2.1 A FOSA task force is set up to develop well-prepared environment for the safety risk management of an RNP AR APCH in the FOSA session.

2.2.2 A FOSA task force organizes the information listed in 2.1.4 to clarify the system definition of the proposed RNP AR APCH.

2.2.3 The following divisions and offices of JCAB whose personnel are in charge of flight standards, airworthiness, scheduled introduction of RNP AR APCH, air traffic control, procedure design of RNP AR APCH, airspace safety assessment, flight plan/ aeronautical information, flight validation, and air navigation services engineering are the members of the FOSA task force where aircraft operators wishing for the approval of the RNP AR APCH will join. In case that the airport where RNP AR APCH is introduced has some special situation, the divisions and offices of JCAB in charge of the special factor will be consulted about the participation to the FOSA task force.

- (a) Flight Standards Division
- (b) Air Transport Safety Unit
- (c) Airworthiness Division
- (d) Air Navigation Services Planning Division
- (e) Air Traffic Control Division
- (f) Flight Procedures and Airspace Program Office
- (g) Operations and Flight Inspection Division
- (h) Flight Inspector
- (i) Air Navigation Services Engineering Division
- (j) Aircraft Operator
- (k) Other

2.2.4 A FOSA task force fully briefs about the system definition of the proposed RNP AR APCH to attendees of the FOSA session in advance.

2.2.5 A FOSA task force receives a safety assessment document which is recorded the outcome of the safety risk assessment at the FOSA session.

2.3 FOSA Clerical Staff

2.3.1 FOSA clerical staff is put to deal with any clerical works to conduct a FOSA. FOSA clerical staff consists of Flight Standards Division and Flight Procedures and Airspace Program Office.

2.3.2 FOSA clerical staff engages in the following matters.

- (a) Collecting and preparing materials related to a FOSA
- (b) Calling a FOSA task force and a FOSA session
- (c) Being a facilitator of a FOSA session (in a non-judgmental attitude)
- (d) Drafting a report of the outcome of a FOSA, and controlling a safety assessment document
- (e) Controlling hazard checklists to be utilized in 3.4.3

Chapter 3: SAFETY RISK MANAGEMENT

3.1 Steps of Safety Risk Management

A safety risk management in a FOSA session is conducted through the following steps depicted in the figure below.

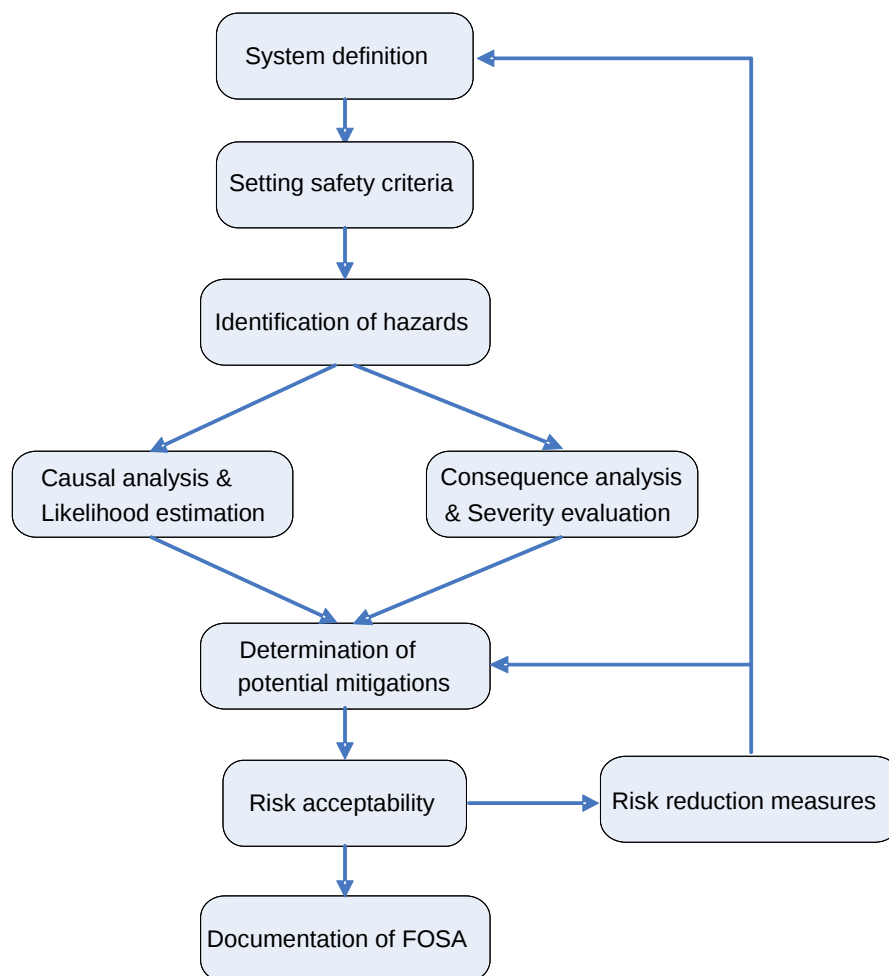


Figure 1: Steps in the safety risk management of FOSA

3.2 System Definition

In order to clarify the operational environment and the operational procedures of a proposed RNP AR APCH as well as the advantageous effect brought by the RNP AR APCH and so forth, items listed in 2.1.4 shall be confirmed in a FOSA session.

3.3 Setting Safety Criteria

With the exception that there is any special reason to do so, a FOSA session uses the methodology to judge the tolerability of risks by the severity of occurrence and the possibility of occurrence as described in the ICAO's Safety Management Manual (Doc 9859) for the safety risk assessment.

3.4 Identification of Hazards

3.4.1 Considering the operational environment and the operational procedures of a proposed RNP AR APCH and so forth described in 3.2 as prerequisites, as well as considering any operational situations beyond the normal operations of aircraft such as contingencies, further considering multiple contributors for human errors, a FOSA session shall identify any potential hazards to induce accidents and/or serious incidents.

3.4.2 The following items shall be covered in the hazard identification.

- (a) Navigation system of the aircraft
- (b) Aircraft performance
- (c) Flight crew operations
- (d) Aircraft failures
- (e) ATC operations
- (f) Flight procedure design
- (g) Route spacing
- (h) Obstacle clearance
- (i) Navigation database
- (j) CNS infrastructure

3.4.3 A FOSA session uses the example of hazards and the method of identifying hazards described in the following documents for the hazard identification. A FOSA session also uses the checklist of hazards identified in the previous FOSA.

- (a) ICAO: Performance-based Navigation (PBN) Manual (Doc 9613)
- (b) EUROCONTROL: Guidance Material on Flight Operational Safety Assessment (FOSA) for RNP AR APCH

3.5 Consequence Analysis and Severity Evaluation

A FOSA session analyses the possible consequence of the identified hazard in 3.4 above, taking as reference the worst foreseeable situation, and evaluates the degree of damage by using the following five-point safety risk severity table.

[Note] When evaluating the worst possible consequences, the potential mitigations (safety risk mitigations which already exist) need to be considered. More than one potential mitigation may exist. The aircraft equipment like a head-up display to increase situational awareness of flight crew, the alerting function for the flight course deviation, the training of flight crew and air traffic controllers for contingencies, the actual vertical separation between the aircraft and obstacles and so forth, need to be considered as potential mitigations for RNP AR APCH.

Level	Severity of Occurrence	Meaning
A	Catastrophic	– Aircraft destroyed – Multiple deaths
B	Hazardous	– A large reduction in safety margins, physical distress or a workload such that the operators cannot be relied upon to perform their tasks accurately or completely

		– Serious injury – Major equipment damage
C	Major	– A significant reduction in safety margins, a reduction in the ability of the operators to cope with adverse operating conditions as a result of increase in workload, or as a result of conditions impairing their efficiency – Serious incident – Injury to persons
D	Minor	– Nuisance – Operating limitations – Use of emergency procedures – Minor incident
E	Negligible	– Little consequences

[Note] The severity is classified with consideration for the scale of damage on human lives and/or properties, and operational sustainability.

Figure 2: Safety risk severity table

3.6 Causal Analysis and Likelihood Estimation

A FOSA session estimates the probability that the worst foreseeable consequence of each hazard evaluated in 3.5 will occur by using the following five-point table.

Level	Probability of Occurrence	Meaning
5	Frequent	Likely to occur many times (has occurred frequently)
4	Occasional	Likely to occur sometimes (has occurred infrequently)
3	Remote	Unlikely to occur, but possible (has occurred rarely)
2	Improbable	Very unlikely to occur (not known to have occurred)
1	Extremely improbable	Almost inconceivable that the event will occur

[Note] The probability is classified with consideration for the history of occurrence of identical or similar event.

Figure 3: Safety risk probability table

3.7 Determination of Potential Mitigations and Assessment of Risk Acceptability

A FOSA session determines potential mitigations on each hazard. Based on these mitigations, a FOSA session assesses whether the safety risk of each hazard is acceptable or not comprehensively by applying the severity of occurrence identified in 3.5 and the probability of occurrence identified in 3.6 to the following five-by-five matrix.

Risk probability	Risk severity				
	Catastrophic	Hazardous	Major	Minor	Negligible
Frequent	Unacceptable	Unacceptable	Unacceptable	ALARP	ALARP

Occasional	Unacceptable	Unacceptable	ALARP	ALARP	ALARP
Remote	Unacceptable	ALARP	ALARP	ALARP	Acceptable
Improbable	ALARP	ALARP	ALARP	Acceptable	Acceptable
Extremely improbable	Acceptable	Acceptable	Acceptable	Acceptable	Acceptable

[Note] The acronym ALARP expresses that the level of a safety risk is between acceptable and unacceptable, which means that the safety risk should be reduced to a level that is “As Low As Reasonably Practicable”. If the safety risk of the hazard falls under this category, the effect and the cost resulted from the risk mitigations should be examined, and also the technical possibility should be considered, then after mitigating the risk as low as reasonably practicable, the inevitable risk is to be accepted.

Figure 4: Safety risk assessment matrix

3.8 Risk Reduction Measures

3.8.1 A FOSA session considers solutions for unacceptable risks either through the elimination of the hazard or through the mitigation to reduce the risk of the hazard to an acceptable level.

3.8.2 A FOSA session pays attention to the higher risks (with greater severity and higher possibility) which should be mitigated with greater urgency.

3.8.3 A FOSA session gives a preference to the mitigation which has the biggest effect and is the easiest to carry out when multiple measures are envisaged.

3.8.4 A FOSA session combines advantage of multiple mitigations when a single measure cannot reduce the safety risk sufficiently.

3.8.5 A FOSA session considers the degree of risk reduction by the selected mitigation and the residual risk after the risk reduction.

3.9 Documentation of FOSA

3.9.1 A FOSA session draws up a safety assessment document on the process of the safety risk management and the outcome of the risk assessment.

[Note] Not only recording the outcome of the risk assessment, i.e. the acceptability of the risk, but also the background to reach the outcome shall be recorded in the safety assessment document. The steps of safety risk management described in 3.1 (system definition, setting safety criteria, identification of hazards, consequence analysis and severity evaluation, causal analysis and likelihood estimation, determination of potential mitigations, assessment of risk acceptability, risk reduction measures) shall be all recorded in the safety assessment document.

3.9.2 A FOSA session uses Form 1 to record the identified hazards and the outcome of risk assessment on each hazard in the safety assessment document.

3.9.3 A FOSA session uses Form 2 to record the process of safety risk management on each hazard respectively in the safety assessment document. All hazards identified in the FOSA session are recorded whatever minor things may be.

Chapter 4: HANDLING OF THE OUTCOME OF FOSA

4.1 Documentation Management

A safety assessment document is reported to the FOSA task force. The document is controlled by FOSA clerical staff.

4.2 Execution of Safety Risk Mitigations

The divisions and offices of JCAB participated in the FOSA task force shall carry out the necessitated risk reduction measures described in the safety assessment document.

[Note] In accordance with annex 8, chapter 7, ‘miscellaneous provisions’ of “Rules of Operational Approval and Examination Procedures for Area Navigation (RNAV)” dated 7 June 2007, aircraft operators are obliged to carry out the risk reduction measures described in a FOSA document.

Chapter 5: POST-IMPLEMENTATION ASSESSMENT

5.1 Safety Monitoring after Implementation of RNP AR APCH

5.1.1 Safety monitoring of RNP AR APCH shall be conducted after starting the actual operation in order to verify the effectiveness of risk mitigations.

5.1.2 Safety monitoring of implemented RNP AR APCH is conducted through the daily duty of the stakeholders listed in 2.2.3, and the collected data shall be reported to the FOSA clerical staff.

5.1.3 FOSA clerical staff uses Form 3 to organize reported hazard-related information.

5.1.4 FOSA clerical staff organizes the report based on article 111-4 of Civil Aeronautics Law and the report obliged by Rules of Operational Approval and Examination Procedures for Area Navigation (RNAV) if those reports are related to RNP AR APCH.

5.2 Safety Assessment after Implementation of RNP AR APCH

5.2.1 Based on the data collected through 5.1.2, 5.1.3 and 5.1.4, and the flight track data analysed through regular sampling, FOSA clerical staff reviews the actual operational conditions of implemented RNP AR APCH.

5.2.2 Post-implementation assessment is conducted at the point when one year having passed since the operational start of the established or amended RNP AR APCH, in principle. However, it might be conducted earlier when FOSA clerical staff recognizes the need to do so, based on the review described in 5.2.1 above.

5.2.3 If the post-implementation assessment identifies influential or likely influential events on the safe operation of RNP AR APCH, countermeasures shall be considered and carried out. In this case, a FOSA session is held to conduct a safety risk management.

5.2.4 A safety assessment document is revised if the post-implementation assessment brings new mitigations and so forth, and necessitates the update of the document.

Supplementary Provision:

Procedures established herein will be effective on 5th October 2011.

Form 1 List of Identified Hazards and Outcome of Safety Risk Assessment on each Hazard

Outcome of Safety Risk Assessment on each Hazard and Mitigations

List of Hazards					
No.	Code	Identified Hazard	Outcome of Assessment		Mitigation / Residual Risk
(1)	*1	*2	*3	*3	*4
(2)					
(3)					
(4)					
(5)					
e.g.	RJTT23-101	Error in navigation database	3B	ALARP	7

Risk Tolerability Matrix

Risk probability		Risk severity				
		Catastrophic	Hazardous	Major	Minor	Negligible
		A	B	C	D	E
Frequent	5	(5A) Unacceptable	(5B) Unacceptable	(5C) Unacceptable	(5D) ALARP	(5E) ALARP
Occasional	4	(4A) Unacceptable	(4B) Unacceptable	(4C) ALARP	(4D) ALARP	(4E) ALARP
Remote	3	(3A) Unacceptable	(3B) ALARP	(3C) ALARP	(3D) ALARP	(3E) Acceptable
Improbable	2	(2A) ALARP	(2B) ALARP	(2C) ALARP	(2D) Acceptable	(2E) Acceptable
Extremely improbable	1	(1A) Acceptable	(1B) Acceptable	(1C) Acceptable	(1D) Acceptable	(1E) Acceptable

*1 Put alphanumeric code (airport name, name of approach procedure, serial number, etc.) as a reference for the identified hazard in the safety risk management. It should be used for ease of reference. e.g.: RJTT23-101

*2 Put the title of identified hazard.

*3 Put acceptability of the hazard. In addition, put the number-alphabet combination code in the five-by-five matrix above and colour the column in red, yellow or green appropriately.

*4 Put risk reduction measures and/or residual risks, which make the hazard currently acceptable but may need to increase safety in the future, may need technical development, or may need to monitor after introduction. Mitigations and residual risks would be more than one, so the details are described separately as needed. e.g.: Number mitigations/residual risks serially, and put the number only in the table.

Form 2 Process of Safety Risk Management on each Hazard

Hazard (1)	*1						
Code	Class	Key Word	Acceptability	5 x 5	Severity	Probability	mitigation
*2	*3	*4	*5	*6	*7	*8	*9
1. Occurrence	*10						
2. Cause	*11						
3. Potential Mitigation	*12						
4. Worst Consequence	*13						
5. Severity	*14						
6. Probability	*15						
7. Assessment Process	*16						
8. Mitigation	*17						
9. Residual Risk	*18						
10. Remarks	*19						

*1 Put the title of identified hazard. The same title put in the Form 1.

*2 Put alphanumeric code (airport name, name of approach procedure, serial number, etc.) as a reference for the identified hazard in the safety risk management. It should be used for ease of reference. e.g.: RJTT23-101

*3 Put the code of relevant area for the grouping of identified hazards. e.g.: For the hazard related to air traffic control, put "ATC" in the column.

*4 Put key words to subdivide hazards.

*5 Put the outcome of risk assessment as "Unacceptable", "ALARP" or "Acceptable". Colour the column in red, yellow or green as needed.

*6 Put the number-alphabet combination code in the five-by-five safety risk assessment matrix.

*7 Put the degree of severity in the five point safety risk severity table.

*8 Put the degree of probability in the five point safety risk probability table.

*9 Put the need of mitigations either 'necessary' or 'unnecessary'.

*10 Put the situation of the occurrence of the hazard.

*11 Put the cause of the occurrence of the hazard.

*12 Put the mitigations which already exist. In addition, put the assumed operational procedures, ATC procedures, etc.

*13 Put the worst consequence possibly happen even after considering all the potential mitigations.

*14 Put the reason why that severity is chosen from the five-point safety risk severity table.

*15 Put the reason why that probability is chosen from the five-point safety risk probability table.

*16 Put the repeated process of safety risk management. The hazard assessed as unacceptable in the first risk assessment may be assessed as ALARP in the next risk assessment by applying additional mitigations.

*17 Put the required mitigation to make the hazard acceptable.

*18 Put the residual risks associated with the hazard, which are currently acceptable but may need technical development or post-implementation monitoring in order to increase safety in the future.

*19 Put any information to keep in mind.

Form 3 RNP AR APCH Hazard Information Log

Item	Content
Date & Time of Occurrence	YY MM DD hh mm (JST)
Site of Occurrence	(Airport, Name of RNP AR APCH, Altitude, etc.)
Name of AO Flight No. Type of A/C Reg. No.	
Detail of Hazard	
Cause	
Other	

— END —